PATENT ABSTRACTS OF JAPAN

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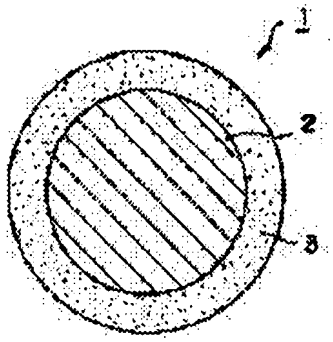
(54) COMPOSITE POWDER FOR THERMAL SPRAYING

(57)Abstract:

PURPOSE: To produce composite powder for thermal spraying capable of forming sprayed film excellent in thermal impact resistance, wear resistance and adhesion by coating the surface of Ti powder with an Ni layer.

CONSTITUTION: The surface of Ti powder 2 is coated with an Ni layer 3 to obtain composite powder 1 for thermal spraying. At this time, the average grain size of the composite powder 1 for thermal spraying is preferably regulated to 10 to 150μm, particularly to about 40 to 70μm. Moreover, the thickness of the coated Ni layer 3 is preferably regulated to ≥5μm and the ratio of the grain size of the Ti powder: the thickness of the Ni layer to ≤10:1. This composite powder can be obtd. by subjecting the Ti powder having about 20 to 100μm average grain size and the Ni powder having about 0.1 to 10μm average grain size to mechanical plating.



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TITLE: COMPOSITE POWDER FOR THERMAL SPRAYING

PUBN-DATE: October 1, 1996

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APPL-NO: JP07083373

APPL-DATE: March 15, 1995

INT-CL (IPC): C23C004/06

ABSTRACT:

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DERWENT-ACC-NO: 1996-493661

DERWENT-WEEK: 199649

TITLE: Composite powder for flame coating giving improved thermal impact resistance - comprising **nickel@-coated titanium@ powder with specified particle size and nickel@ layer** thickness

PATENT-ASSIGNEE: MITSUBISHI MATERIALS CORP[MITV]

PRIORITY-DATA: 1995JP-0083373 (March 15, 1995)

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INT-CL (IPC): C23C004/06

ABSTRACTED-PUB-NO: JP 08253851A

BASIC-ABSTRACT:

The surface of **Ti powder is coated with a Ni layer**. Average particle size of the composite powder is 10-150 mum. Thickness of the Ni layer is more than 5 mum. **Ti powder particle size to Ni layer** thickness is less than 10:1.

ADVANTAGE - Thermal impact, abrasion resistance and adhesion are increased.

CHOSEN-DRAWING: Dwg.1/3

TITLE-TERMS: COMPOSITE POWDER FLAME COATING IMPROVE THERMAL IMPACT RESISTANCE
COMPRISE **NICKEL@ COATING TITANIUM@ POWDER SPECIFIED PARTICLE SIZE**
NICKEL@ LAYER THICK

DERWENT-CLASS: M13 M22

CPI-CODES: M13-C; M22-H03F;

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The end for thermal spraying of composite powder it is characterized by coming to cover the front face of Ti powder with nickel layer.
[Claim 2] The end for thermal spraying of composite powder which it comes to cover the front face of Ti powder with nickel layer, and is characterized by mean particle diameter being 10-150 micrometers.
[Claim 3] The thickness of nickel layer which covers the front face of unalloyed ti powder is in the end for thermal spraying of composite powder it is characterized by being 5 micrometers or more and being less than [Ti powder particle-size:nickel thickness =10]:1.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is related in the end of the composite powder for thermal spraying for forming the sprayed coating excellent in thermal shock resistance, abrasion resistance, and adhesion in the face side of the engine valve for inhalation of air especially about the composite powder end for thermal spraying for forming a sprayed coating in the front face of the equipment component which receives impact friction at the same time rapid heating quenching is carried out.
[0002]
[Description of the Prior Art] Generally, since the intermetallic compound is excellent in high temperature strength and elevated-temperature corrosion resistance, it forms an intermetallic-compound coat in the inside or front face of various equipments exposed to a severe ambient atmosphere by approaches, such as thermal spraying, and is aiming at improvement in the use life of various equipments.
[0003] For example, in JP,4-21756,A, 20 - 63% of the weight of aluminum powder is contained, and the approach of forming a TiAl system intermetallic-compound coat is proposed by carrying out thermal spraying of the mixed powder with which the remainder consists of Ti powder.
[0004] Therefore, when it is going to form a NiTi system intermetallic-compound coat, what is necessary's being just to carry out thermal spraying of the mixed powder which consists of Ti powder and nickel powder which blended with the predetermined rate and were mixed is happening to think simply.
[0005] however, like the mixed powder which consists of Ti (specific gravity: 4.5) powder and aluminum (specific gravity: 2.7) powder It is rare to change the mixed ratio by the specific gravity difference during mixed powder conveyance, even if it supplies the mixed powder which consists of comparatively little metal powder of a specific gravity difference to a thermal-spraying nozzle and forms a sprayed coating. Like [although there is little obtained concentration change of Ti and aluminum of a sprayed coating] the mixed powder which consists of nickel (specific gravity: 8.9) powder and Ti (specific gravity: 4.5) powder If the mixed powder which consists of big metal powder of a specific gravity difference is supplied to a thermal-spraying nozzle, while resulting [from a hopper] in a thermal-spraying nozzle, according to a specific gravity difference, a mixed ratio will change and the NiTi system intermetallic-compound coat of a uniform component presentation will not be obtained. Therefore, in order to form the intermetallic-compound coat which consists of a large metal of a specific gravity difference like nickel and Ti by thermal spraying, the NiTi system intermetallic-compound powder which atomized the molten metal beforehand ingoted by the predetermined component presentation, and was obtained is used as thermal-spraying powder, and forming a NiTi system intermetallic-compound sprayed coating is also considered.
[0006]
[Problem(s) to be Solved by the Invention] However, although a NiTi system intermetallic compound is excellent in elevated-temperature corrosion resistance and it has the high degree of hardness From the

place which is inferior in the joining nature between NiTi system intermetallic-compound powder, and the joining nature to a base material front face The sprayed coating obtained by carrying out thermal spraying of the NiTi system intermetallic-compound powder atomized and obtained tends to exfoliate from a base material. While receiving the thermal shock of rapid heating quenching like the face side of the engine valve for inhalation of air especially, there was a technical problem of a crack arising and exfoliating in the sprayed coating formed in the part which repeats a collision and friction.
[0007]
[Means for Solving the Problem] Then, the thermal shock resistance which does not exfoliate even if it carries out thermal spraying to the part which receives impact friction at the same time this invention person etc. receives the thermal shock of rapid heating quenching like the face side of the engine valve for inhalation of air, If plasma-arc thermal spraying of the end of composite powder it comes to cover the front face of Ti powder with nickel layer is carried out as a result of inquiring that the sprayed coating excellent in abrasion resistance and adhesion should be formed While passing through the inside of a plasma arc the end of composite powder, a NiTi intermetallic compound generates on the boundary of unalloyed ti powder and a pure nickel coat. The sprayed coating formed in the base material front face has the organization where Ti particle covered with the NiTi intermetallic-compound layer in nickel base carried out homogeneity distribution. The research result of not exfoliating even if it excels in adhesion and receives a thermal shock and impact friction, since this sprayed coating is using nickel as the junction metal was obtained.
[0008] This invention is made based on this research result, and has the description in the end for thermal spraying which comes to cover the front face of Ti powder with nickel layer of composite powder.
[0009] A mean-particle-diameter:20-100micrometer Ti powder and mean-particle-diameter:0.1-10micrometer nickel powder are mixed to homogeneity with a mixer the composite powder end for thermal spraying of this invention. The obtained mixed powder is inserted in a container, and nickel powder is made to stick to the front face of Ti powder by pressure by making mixed powder agitate with a rabble, and it manufactures by forming nickel layer (the approach of forming nickel layer by this approach is hereafter called mechanical plaiting). The end of composite powder it was obtained by mechanical plaiting is sifted, the composite powder end of a 10-150-micrometer diameter is classified and taken out, and it considers as the composite powder end for thermal spraying of this invention. Having set particle size after [for thermal spraying / composite powder] this invention to 10-150 micrometers In the particle size of less than 10 micrometers, Ti powder and nickel layer fuse completely in the plasma. Since it becomes impossible to maintain the complex tissue of Ti and nickel, preferably on the other hand While passing through the short interior of the plasma which the heat capacity in the end for thermal spraying of composite powder was too large, and generated at the tip of a thermal spraying gun when 150 micrometers was exceeded, nickel layer does not fully fuse. Therefore, since the formed sprayed coating does not stick to a substrate, but becomes still more inadequate [generation of a NiTi intermetallic compound] and sufficient abrasion resistance is not obtained, it is because it is not desirable. A much more desirable particle size after [for thermal spraying / composite powder] this invention is 40-70 micrometers.
[0010] nickel layer in the end for thermal spraying of composite powder which consists of Ti powder and nickel layer of this invention is 5 micrometers or more, and is less than [thickness =10]:1 (much more preferably 5:1) of the particle-size:nickel layer of Ti powder. the thickness of nickel layer -- less than 5 micrometers -- and particle-size [of Ti powder]: -- thickness =10**: of nickel layer -- since the amount [in / that it is 1 / a sprayed coating] of nickel is insufficient and the adhesion over a base material runs short, it is not desirable.
[0011] Therefore, as for the thickness of nickel layer in the composite powder end for thermal spraying of this invention, it is desirable to manufacture by the describing [above] mechanical plaiting method from the place which needs to be covered in large quantities thickly, and it becomes [production time] long by the other approaches and is not more efficient than nickel layer formed by approaches, such as the usual plating.

[0012] The configuration and operation in the end for thermal spraying of composite powder of this invention are explained based on a drawing.
[0013] Drawing 1 is a sectional view after [for thermal spraying / composite powder] this invention, and drawing 2 is a cross-section explanatory view in the condition of having supplied the composite powder end for thermal spraying of this invention into the plasma, and having formed the sprayed coating in the base material front face.
[0014] 1 has the structure which covered the front face of the Ti powder 2 with the nickel layer 3 in the end of composite powder for this invention thermal spraying it is shown in drawing 1 . If 1 is supplied into the plasma 6 in this end of composite powder for this invention thermal spraying as shown in drawing 2 , the end for thermal spraying of composite powder the NiTi intermetallic-compound layer 4 was formed in the boundary of the Ti powder 2 and the nickel layer 3, and this NiTi intermetallic-compound layer 4 was formed will collide with a base material 5, and a sprayed coating 7 will be formed. although it will be easy to oxidize if Ti powder exists independently in the atmospheric-air plasma -- the object for this invention thermal spraying -- since it is covered with the nickel layer 3 like end of composite powder 1, Ti powder does not oxidize in a plasma metal spray
[0015] Thus, since the obtained sprayed coating 7 has the organization where the composite particle which covered Ti particle 2a with NiTi intermetallic-compound layer 4a with high hardness carried out homogeneity distribution, it does not exfoliate even if the above-mentioned sprayed coating 7 receives a thermal shock and impact friction from a place excellent in adhesion [as opposed to a substrate in nickel base], and it moreover contains NiTi intermetallic-compound layer 4a in nickel base excellent in ductility, it is excellent also in abrasion resistance.
[0016]
[Example] The unalloyed ti powder and pure nickel powder which have the mean particle diameter shown in Table 1 were prepared, these powder was blended so that it might become the rate shown in Table 1, the mixer was loaded with the obtained combination powder with the diameter:6mm stainless steel ball, after carrying out churning mixing, it took out from the mixer with the stainless steel ball, and mixed powder was produced.
[0017] It agitated so that the well-closed container made from stainless steel might be further loaded with the obtained mixed powder, it might be ground and might be crushed, and nickel layer was covered on Ti powder front face, and 1-10 were produced in the end (henceforth the end of this invention composite powder) of composite powder for this invention thermal spraying it has the mean particle diameter and nickel thickness of Ti which classify the end of composite powder it was obtained, and are shown in Table 1.
[0018] The engine valve made from Ti alloy which consists of Ti-6%aluminum-4%V was prepared, 1-10 were used for the face side of this engine valve made from Ti alloy in the above-mentioned end of this invention composite powder, the atmospheric-air plasma metal spray was performed on condition that the following, and the thickness:100micrometer sprayed coating was formed.
[0019] atmospheric-air plasma metal spray condition plasma gas: -- Ar gas and plasma gas flow rate:1.1x10-3m3 -- /sec., current:400A, electrical-potential-difference:80V, spray rate:0.5gr/sec., carrier gas flow rate:5.7x10-5m3/sec., spray distance:100mm, and face side passing speed:500mm/sec.
[0020] The front face of the sprayed coating formed in the end of this invention composite powder using 1 is polished, and the sketching Fig. of an organization observed with the metaloscope is shown in drawing 3 . It turns out that the sprayed coating formed in the end of this invention composite powder using 1 has the organization which Ti particle 2a covered with NiTi intermetallic-compound layer 4a in nickel base 3a distributed to homogeneity so that clearly also from the sketching Fig. of drawing 3 .
[0021] The engine valve made from Ti alloy which has the sprayed coating obtained by carrying out thermal spraying of 1-10 in the end of this invention composite powder was incorporated as a bulb for inhalation of air of a 2000 cc gasoline engine, and the engine was operated on the conditions of number of rotations:7500r.p.m. operation-time:100 hours. the ratio of the sprayed coating which the sprayed coating of the face side of the engine valve made from Ti alloy received the thermal shock by the repeat of 25 degrees C and 950-degree C cooling heating at this time, and the sprayed coating of a face side has

received a valve seat and impact friction further, took out the engine valve after operation termination of 100 hours, and was formed in the engine valve face side -- abrasion loss and the existence of exfoliation were observed and that result was shown in Table 1.

[0022] the former furthermore ingoted, atomized and obtained for the comparison so that nickel:Ti=1:1 might become comparatively -- atomization powder -- conditions same as the above -- the face side of the above-mentioned engine valve made from Ti alloy -- thermal spraying -- carrying out -- the same -- carrying out -- as the bulb for inhalation of air of a 2000 cc gasoline engine -- incorporating -- the ratio of the sprayed coating of after operation termination of 100 hours, and a face side -- abrasion loss and the existence of exfoliation were observed and the result was shown in Table 1.

[0023]

[Table 1]

区別		原料粉末		配合割合	複合粉末の構成				溶射皮膜	
		純Ti粉末の平均粒径 (μm)	純Ni粉末の平均粒径 (μm)	純Ti粉末：純Ni粉末	Tiの平均粒径 (μm)	Ni層厚 (μm)	複合粉末の平均粒径 (μm)	比摩耗量 ($\times 10^{-8}$ mm^3/kg)	剥離の有無
本発明複合粉末	1	40.8	3.1	5:1	47.5	5.0	57.5	6.5	なし
	2	50.1	4.2	3:1	51.3	5.9	63.1	7.9	〃
	3	63.2	3.1	2:1	52.9	7.2	67.3	8.9	〃
	4	70.6	4.2	2:1	63.9	6.0	75.9	9.2	〃
	5	22.2	0.2	10:1	22.2	5.1	32.4	9.0	〃
	6	28.3	0.5	5:1	23.8	5.0	33.8	7.1	〃
	7	33.4	1.2	2:1	24.1	5.8	35.7	8.8	〃
	8	79.2	6.3	10:1	71.3	5.9	83.1	9.6	〃
	9	86.6	6.3	10:1	76.8	5.7	88.2	9.2	〃
	10	98.9	9.8	10:1	87.1	6.2	99.5	9.1	〃
従来複合粉末		NiTiの溶製アトマイズ粉末						189.6	あり

[0024]

[Effect of the Invention] exfoliating, even if the sprayed coating obtained from the result shown in Table 1 by carrying out thermal spraying of 1-10 in the end of this invention composite powder receives the thermal shock of long duration, and impact friction -- there is nothing -- a ratio -- a place with little abrasion loss shows excelling also in abrasion resistance.

[0025] As mentioned above, the sprayed coating excellent in thermal shock resistance, abrasion resistance, and adhesion can be formed the composite powder end for thermal spraying of this invention, and the effectiveness which was excellent on industry is brought about.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a sectional view after [for thermal spraying / composite powder] this invention.
[Drawing 2] It is the cross-section explanatory view showing the behavior of the composite powder end when carrying out the plasma metal spray of the composite powder end for thermal spraying of this invention.
[Drawing 3] It is the organization sketching Fig. of the sprayed coating formed using the composite powder end for thermal spraying of this invention.
[Description of Notations]
1 The End for this Invention Thermal Spraying of Composite Powder
2 Ti Powder
3 Nickel Layer
4 NiTi Intermetallic-Compound Layer
5 Base Material
6 Plasma
7 Sprayed Coating
2a Ti particle
4a NiTi intermetallic-compound layer

[Translation done.]

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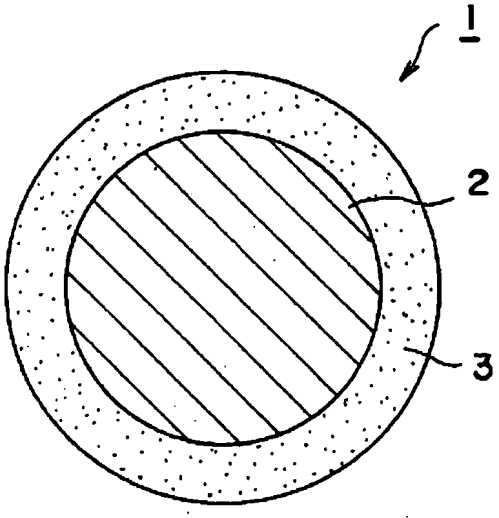
(54)【発明の名称】　溶射用複合粉末

(57)【要約】
【目的】　耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成するための溶射用複合粉末を提供する。
【構成】　Ｔｉ粉末２の表面にＮｉ層３を被覆してなる平均粒径：１０～１５０μｍの溶射用複合粉末であって、Ｎｉ層３の厚さは５μｍ以上であり、かつＴｉ粉末粒径：Ｎｉ層厚の比が１０以下：１である。



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【特許請求の範囲】

【請求項1】　Ｔｉ粉末の表面をＮｉ層で被覆してなることを特徴とする溶射用複合粉末。

【請求項2】　Ｔｉ粉末の表面をＮｉ層で被覆してなり、平均粒径が１０～１５０μｍであることを特徴とする溶射用複合粉末。

【請求項3】　純Ｔｉ粉末の表面を被覆するＮｉ層の厚さは５μｍ以上であり、かつＴｉ粉末粒径：Ｎｉ層厚＝１０以下：１であることを特徴とする溶射用複合粉末。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、急熱急冷されると同時に衝撃摩擦を受ける装置部品の表面に溶射皮膜を形成するための溶射用複合粉末に関し、特に吸気用エンジンバルブのフェース面に耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成するための溶射用複合粉末に関するものである。

【０００２】

【従来の技術】一般に、金属間化合物は高温強度および高温耐食性に優れているために、過酷な雰囲気にさらされる各種装置の内面または表面に溶射等の方法により金属間化合物皮膜を形成し、各種装置の使用寿命の向上を図っている。

【０００３】例えば、特開平４－２１７５６号公報では２０～６３重量％のＡｌ粉末を含有し、残りがＴｉ粉末からなる混合粉末を溶射することによりＴｉＡｌ系金属間化合物皮膜を形成する方法が提案されている。

【０００４】したがって、ＮｉＴｉ系金属間化合物皮膜を形成しようとする場合には、所定割合に配合し混合されたＴｉ粉末およびＮｉ粉末からなる混合粉末を溶射すればよいことは簡単に思い付くことである。

【０００５】しかし、Ｔｉ（比重：４．５）粉末およびＡｌ（比重：２．７）粉末からなる混合粉末のように、比重差の比較的少ない金属粉末からなる混合粉末を溶射ノズルに供給して溶射皮膜を形成しても混合粉末搬送中に比重差による混合比率が変動することは少なく、得られた溶射皮膜のＴｉとＡｌの濃度変化は少ないが、Ｎｉ（比重：８．９）粉末およびＴｉ（比重：４．５）粉末からなる混合粉末のように、比重差の大きな金属粉末からなる混合粉末を溶射ノズルに供給すると、ホッパーから溶射ノズルに至る間に比重差によって混合比率が変化し、均一な成分組成のＮｉＴｉ系金属間化合物皮膜は得られない。そのために、ＮｉとＴｉのような比重差の大きい金属からなる金属間化合物皮膜を溶射により形成するには、あらかじめ所定の成分組成に溶製された溶湯をアトマイズして得られたＮｉＴｉ系金属間化合物粉末を溶射粉末として使用し、ＮｉＴｉ系金属間化合物溶射皮膜を形成することも考えられる。

【０００６】

【発明が解決しようとする課題】しかし、ＮｉＴｉ系金

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属間化合物は高温耐食性に優れてかつ高硬度を有しているが、ＮｉＴｉ系金属間化合物粉末相互の溶着性および基材表面に対する溶着性が劣っているところから、アトマイズして得られたＮｉＴｉ系金属間化合物粉末を溶射して得られた溶射皮膜は基材から剥離しやすく、特に吸気用エンジンバルブのフェース面のように急熱急冷の熱衝撃を受けると同時に衝突と摩擦を繰り返す部分に形成された溶射皮膜には亀裂が生じ剥離するなどの課題があった。

【０００７】

【課題を解決するための手段】そこで、本発明者等は、吸気用エンジンバルブのフェース面のような急熱急冷の熱衝撃を受けると同時に衝撃摩擦を受ける個所に溶射しても剥離することのない耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成すべく研究を行った結果、Ｔｉ粉末の表面をＮｉ層で被覆してなる複合粉末をプラズマアーク溶射すると、複合粉末はプラズマアーク中を通過する間に純Ｔｉ粉末と純Ｎｉ被膜の境界でＮｉＴｉ金属間化合物が生成し、基材表面に形成された溶射皮膜はＮｉ素地中にＮｉＴｉ金属間化合物層で被覆されたＴｉ粒子が均一分散した組織を有し、この溶射皮膜はＮｉを接合金属としているために密着性に優れ、熱衝撃および衝撃摩擦を受けても剥離することはないという研究結果が得られたのである。

【０００８】この発明は、かかる研究結果に基づいてなされたものであって、Ｔｉ粉末の表面をＮｉ層で被覆してなる溶射用複合粉末に特徴を有するものである。

【０００９】この発明の溶射用複合粉末は、平均粒径：２０～１００μｍのＴｉ粉末と平均粒径：０．１～１０μｍのＮｉ粉末を混合器により均一に混合し、得られた混合粉末を容器に装入し、撹拌棒で混合粉末を撹拌させることによりＴｉ粉末の表面にＮｉ粉末を圧着させ、Ｎｉ層を形成することにより製造する（以下、この方法によりＮｉ層を形成する方法をメカニカルプレーティングという）。メカニカルプレーティングにより得られた複合粉末をふるいにかけて１０～１５０μｍの径の複合粉末を分級して取り出し、この発明の溶射用複合粉末とする。この発明の溶射用複合粉末の粒径を１０～１５０μｍとしたのは、１０μｍ未満の粒径ではプラズマ中でＴｉ粉末とＮｉ層が完全に溶融し、ＴｉとＮｉの複合組織を維持できなくなるので好ましくなく、一方、１５０μｍを越えると溶射用複合粉末の熱容量が大きすぎて溶射ガン先端に生成した短いプラズマ内部を通過中にＮｉ層が十分に溶融せず、したがって形成された溶射皮膜が基板に密着せず、さらにＮｉＴｉ金属間化合物の生成も不十分となるので十分な耐摩耗性が得られないので好ましくないことによるものである。この発明の溶射用複合粉末の一層好ましい粒径は４０～７０μｍである。

【００１０】この発明のＴｉ粉末およびＮｉ層からなる溶射用複合粉末のＮｉ層は５μｍ以上であり、かつＴｉ

粉末の粒径：Ｎｉ層の厚さ＝１０以下：１（一層好ましくは５：１）である。Ｎｉ層の厚さが５μｍ未満でかつＴｉ粉末の粒径：Ｎｉ層の厚さ＝１０超：１であると、溶射皮膜におけるＮｉ量が不足して基材に対する密着性が不足するので好ましくない。

【００１１】したがって、この発明の溶射用複合粉末におけるＮｉ層の厚さは通常のメッキなどの方法で形成されるＮｉ層よりも厚く大量に被覆する必要があるところから、上記メカニカルプレーティング法により製造することが好ましく、その他の方法では製造時間が長くなって効率的でない。

【００１２】この発明の溶射用複合粉末の構成および作用を図面に基づいて説明する。

【００１３】図１は、この発明の溶射用複合粉末の断面図であり、図２は、この発明の溶射用複合粉末をプラズマ中に供給し、基材表面に溶射皮膜を形成した状態の断面説明図である。

【００１４】図１に示される本発明溶射用複合粉末１は、Ｔｉ粉末２の表面をＮｉ層３で被覆した構造を有している。この本発明溶射用複合粉末１を図２に示されるようにプラズマ６中に供給すると、Ｔｉ粉末２とＮｉ層３の境界にＮｉＴｉ金属間化合物層４が形成され、このＮｉＴｉ金属間化合物層４が形成された溶射用複合粉末が基材５に衝突して溶射皮膜７が形成される。Ｔｉ粉末は大気プラズマ中に単独で存在すると酸化しやすいが、本発明溶射用複合粉末１のようにＮｉ層３で被覆されているのでプラズマ溶射中にＴｉ粉末が酸化することはない。

【００１５】このようにして得られた溶射皮膜７は、延性に優れたＮｉ素地中に、Ｔｉ粒子２ａを硬さの高いＮｉＴｉ金属間化合物層４ａで被覆した複合粒子が均一分散した組織を有し、Ｎｉ素地は基板に対する密着性に優れているところから上記溶射皮膜７は熱衝撃および衝撃摩擦を受けても剥離することがなく、しかもＮｉＴｉ金属間化合物層４ａを含むので耐摩耗性にも優れている。

【００１６】

【実施例】表１に示される平均粒径を有する純Ｔｉ粉末および純Ｎｉ粉末を用意し、これら粉末を表１に示される割合となるように配合し、得られた配合粉末を直径：６㎜のステンレスボールと共にミキサーに装填し、撹拌混合したのちミキサーからステンレスボールと共に取り出して混合粉末を作製した。

【００１７】得られた混合粉末をさらにステンレス鋼製密閉容器に装填し、擦り潰すように撹拌してＴｉ粉末表面にＮｉ層を被覆し、得られた複合粉末を分級して表１に示されるＴｉの平均粒径およびＮｉ層厚を有する本発明溶射用複合粉末（以下、本発明複合粉末という）１～１０を作製した。

【００１８】Ｔｉ－６％Ａｌ－４％Ｖからなるチタン合金製エンジンバルブを用意し、このＴｉ合金製エンジンバルブのフェース面に上記本発明複合粉末１～１０を用いて下記の条件で大気プラズマ溶射を行い、膜厚：１００μｍの溶射皮膜を形成した。

【００１９】大気プラズマ溶射条件

プラズマガス：Ａｒガス、

プラズマガス流量：１．１×10^{-3} m^3 ／sec.、

電流：４００Ａ、

電圧：８０Ｖ、

溶射速度：０．５gr／sec.、

キャリアガス流量：５．７×10^{-5} m^3 ／sec.、

溶射距離：１００㎜、

フェース面移動速度：５００㎜／sec.。

【００２０】本発明複合粉末１を用いて形成した溶射皮膜の表面を研摩し、金属顕微鏡により観察した組織の写生図を図３に示す。図３の写生図からも明らかなように、本発明複合粉末１を用いて形成した溶射皮膜は、Ｎｉ素地３ａ中にＮｉＴｉ金属間化合物層４ａで被覆されたＴｉ粒子２ａが均一に分散した組織を有していることがわかる。

【００２１】本発明複合粉末１～１０を溶射して得られた溶射皮膜を有するＴｉ合金製エンジンバルブを２０００ccのガソリンエンジンの吸気用バルブとして組み込み、

回転数：７５００r.p.m.

運転時間：１００時間

の条件でエンジンを作動させた。この時Ｔｉ合金製エンジンバルブのフェース面の溶射皮膜は２５℃と９５０℃の冷却加熱の繰り返しによる熱衝撃を受け、さらにフェース面の溶射皮膜はバルブシートと衝撃摩擦を受けており、１００時間の運転終了後エンジンバルブを取り出してエンジンバルブフェース面に形成された溶射皮膜の比摩耗量および剥離の有無を観察し、その結果を表１に示した。

【００２２】さらに比較のために、Ｎｉ：Ｔｉ＝１：１の割合となるように溶製しアトマイズして得られた従来アトマイズ粉末を同上の条件で上記Ｔｉ合金製エンジンバルブのフェース面に溶射し、同様にして２０００ccのガソリンエンジンの吸気用バルブとして組み込み、１００時間の運転終了後、フェース面の溶射皮膜の比摩耗量および剥離の有無を観察し、その結果を表１に示した。

【００２３】

【表１】

種別		原料粉末		配合割合	複合粉末の構成				溶射皮膜		
		純Ti粉末の平均粒径（μm）	純Ni粉末の平均粒径（μm）	純Ti粉末：純Ni粉末	Tiの平均粒径（μm）	Ni層厚（μm）	複合粉末の平均粒径（μm）	比摩耗量（$\times 10^{-9}$ mm^3/kg）	剥離の有無
本発明複合粉末	1	40.8	3.1	5:1	47.5	5.0	57.5	6.5	なし
	2	50.1	4.2	3:1	51.3	5.9	63.1	7.9	〃
	3	63.2	3.1	2:1	52.9	7.2	67.3	8.9	〃
	4	70.6	4.2	2:1	83.9	6.0	75.9	9.2	〃
	5	22.2	0.2	10:1	22.2	5.1	32.4	9.0	〃
	6	28.3	0.5	5:1	23.8	5.0	33.8	7.1	〃
	7	33.4	1.2	2:1	24.1	5.8	35.7	8.8	〃
	8	79.2	6.3	10:1	71.3	5.9	83.1	9.6	〃
	9	86.6	6.3	10:1	76.8	5.7	88.2	9.2	〃
	10	98.9	9.8	10:1	87.1	6.2	99.5	9.1	〃
従来複合粉		NiTiの溶製アトマイズ粉末						189.6	あり

【００２４】

【発明の効果】表１に示される結果から、本発明複合粉末１～１０を溶射して得られた溶射皮膜は、長時間の熱衝撃および衝撃摩擦を受けても剥離することがなく、比摩耗量が少ないところから耐摩耗性にも優れていることがわかる。

【００２５】上述のように、この発明の溶射用複合粉末は、耐熱衝撃性、耐摩耗性および密着性に優れた溶射皮膜を形成することができ、産業上すぐれた効果をもたらすものである。

【図面の簡単な説明】

【図１】この発明の溶射用複合粉末の断面図である。

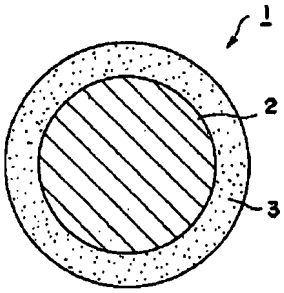
【図２】この発明の溶射用複合粉末をプラズマ溶射する＊時の複合粉末の挙動を示す断面説明図である。

【図３】この発明の溶射用複合粉末を用いて形成した溶射皮膜の組織写生図である。

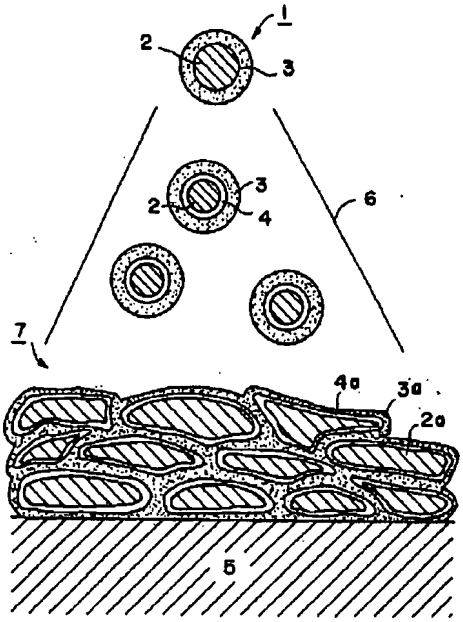
【符号の説明】

1　本発明溶射用複合粉末
2　Ｔｉ粉末
3　Ｎｉ層
4　ＮｉＴｉ金属間化合物層
5　基材
6　プラズマ
7　溶射皮膜
2ａ　Ｔｉ粒子
4ａ　ＮｉＴｉ金属間化合物層

【図1】



【図2】



【図3】